



Dryden Flight Research Center
Edwards, California 93523

DCP-O-007
Revision E

Dryden Centerwide Procedure

Code O

Metrology System

Electronically approved by
Assistant Director of Management Systems

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1.0 PURPOSE OF DOCUMENT

To give guidance to personnel who calibrate, control, purchase, and/or use inspection, measuring, and test equipment.

2.0 SCOPE

This specification is applicable to metrology equipment used directly or indirectly in all Dryden operations and activities for the testing and acceptance of NASA Dryden products, articles, or systems where substantiated data accuracy or safety is required. (Ref NPD 8730.1)

3.0 PROCEDURE OBJECTIVES

1. To define the Center metrology system, which includes the operational interfaces between the various Dryden organizations and the Dryden metrology support contractor.
2. To ensure metrology equipment used directly or indirectly in all Dryden operations and activities for the testing and acceptance of NASA Dryden products, articles or systems where substantiated data accuracy or safety is required are controlled.
3. To assure calibration of aircraft indicating instruments and flight research data gathering instrumentation components and systems installed on Dryden research aircraft, which are controlled by the Flight Operations and Research Engineering Directorates.
4. To define metrology processes or procedural requirements developed for the calibration of inspection, measuring and test equipment.

4.0 RELEVANT DOCUMENTS

4.1 Authority Documents

NPD 8730.1 Metrology & Calibration

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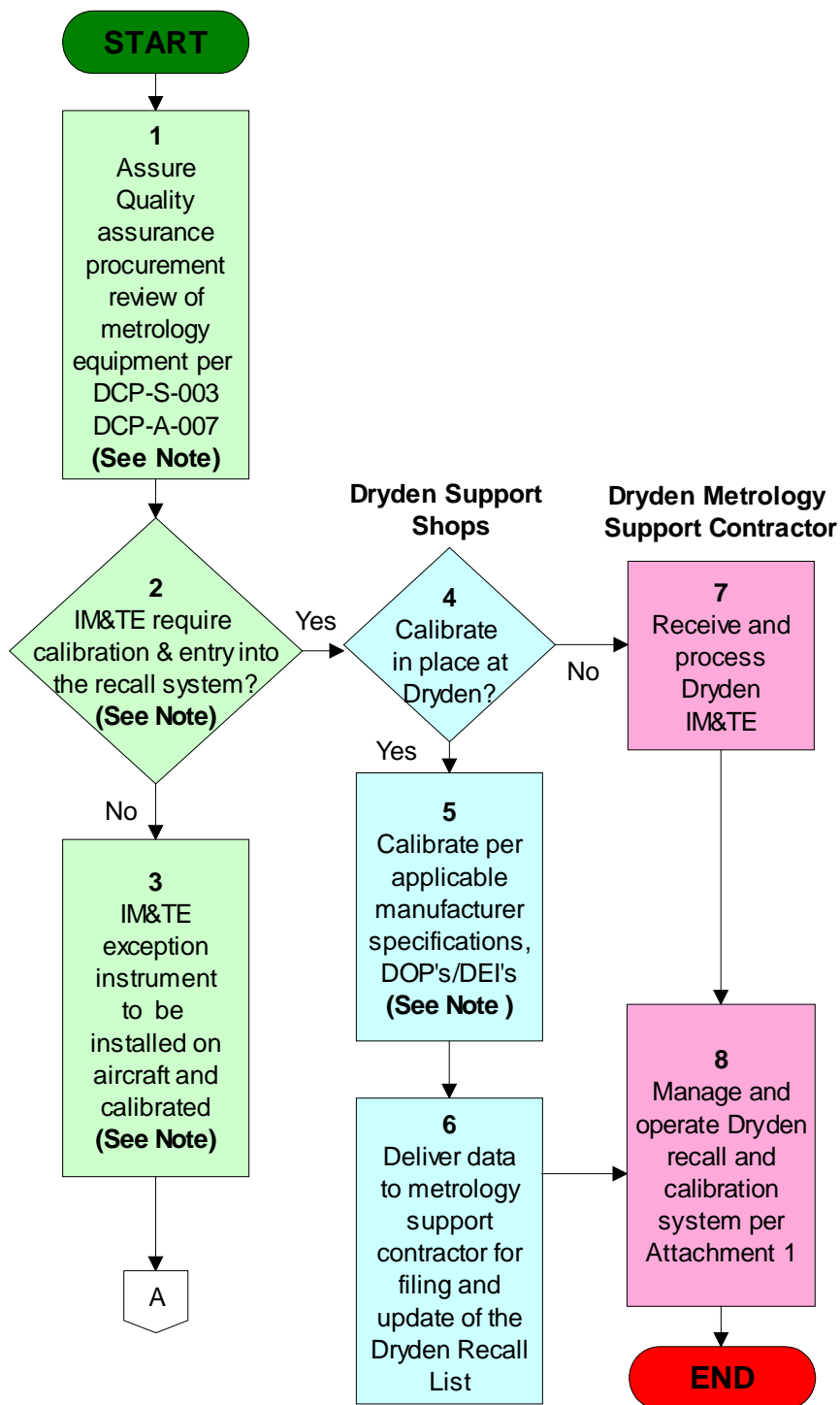
4.2 Referenced Documents

DCP-A-007	Credit Card Purchases by Non-Contracting and Contracting Office Personnel
DCP-S-002	Hazard Management
DCP-S-003	Quality Assurance Review for Purchase Requests
DOP-F-711	Calibration of Load Cells
DOP-R-403	The Fabrication and Installation of a Flight Instrumentation System
DOP-R-404	Calibration Information Management System (CIMS) File Preparation
DOP-R-405	End to End Measurement Test and Calibration for Instrumentation Flight System on Research Aircraft
DOP-R-406	Flight Instrumentation Pre-flight / Post-flight Test
DOP-R-407	Flight Research Sensor Laboratory Calibration Control

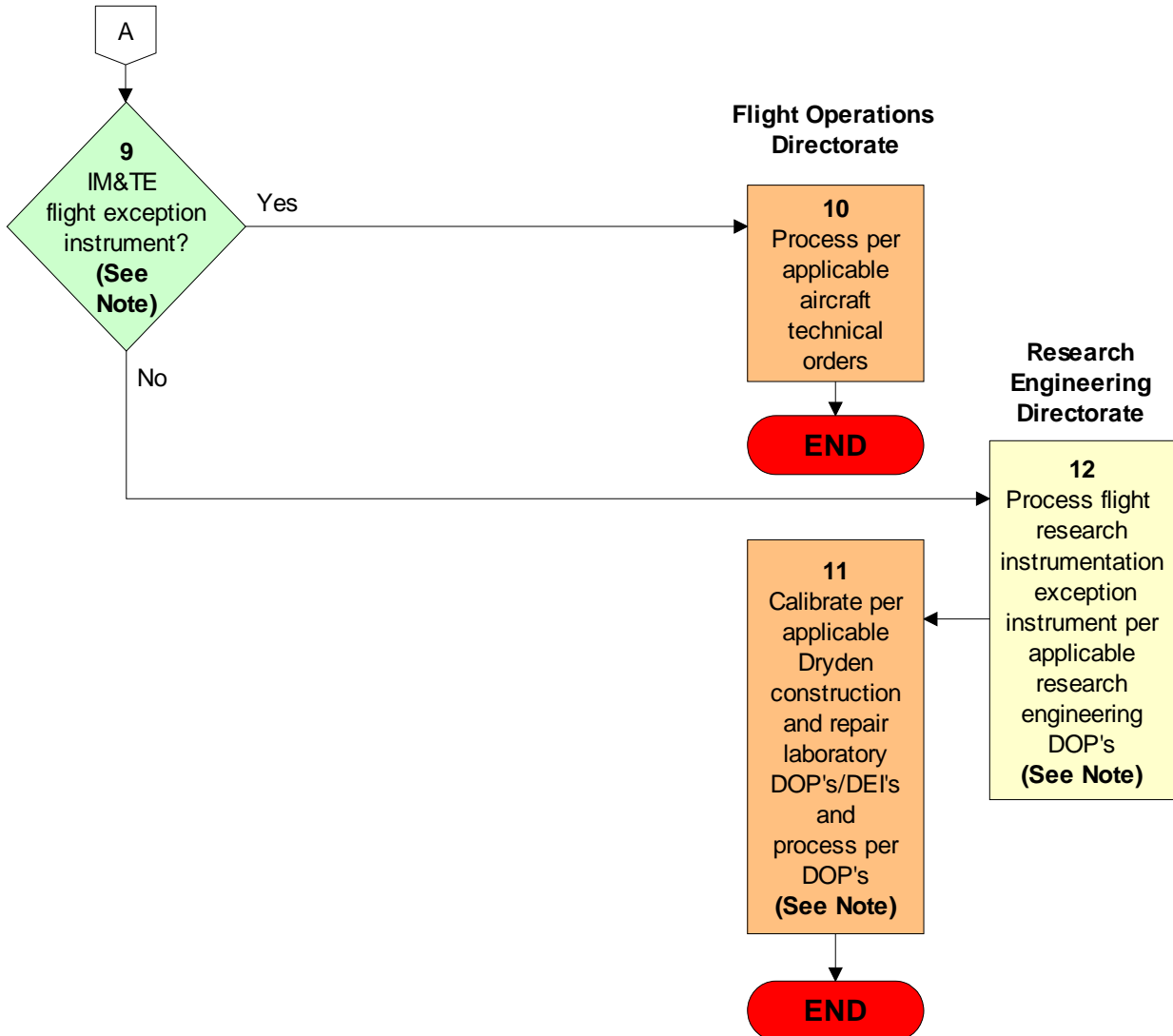
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5.0 METROLOGY SYSTEM FLOWCHART

Inspection, Measuring,
& Test Equipment
(IM&TE)
Purchaser/ User



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**Inspection, Measuring,
& Test Equipment
(IM&TE)
Purchaser/ User**

6.0 NOTES

BLOCK 1

ALL NASA DFRC DIRECTORATE CHIEFS AND CODE X STAFF ORGANIZATIONS WHO CALIBRATE OR UTILIZE METROLOGY EQUIPMENT SHALL DESIGNATE CALIBRATION REPRESENTATIVES WITHIN THEIR DIRECTORATE WHO SHALL ENSURE THE FOLLOWING WITHIN THEIR ORGANIZATION:

- Implementation of this DCP.
- That all metrology equipment utilized throughout their directorate where substantiated data accuracy is required is identified and entered into the metrology database, as required.
- Review and approval of request for calibration extensions. Follow up on extensions granted to ensure data accuracy was not compromised.
- Review and approval of request to remove items from the recall list.
- Review and approval of calibration procedures for specialized test equipment when standard procedures do not exist or are inadequate.
- Review of the monthly calibration delinquency list ensuring all metrology equipment within their directorate is controlled.
- Initiate immediate action to ensure delinquent metrology equipment identified is located, placed out of service, and delivered to the calibration contractor.
- Ensure the Flight Safety Office is notified when metrology equipment labeled and controlled from an outside source is to be utilized.
- Provide engineering support to Dryden's calibration activities as requested or required.

THE NASA DFRC CHIEF OF RESEARCH ENGINEERING (R) OR THEIR DESIGNATED REPRESENTATIVES SHALL:

- Have responsibility for ensuring that Dryden's research data gathering processes assure required data accuracy and reliability.
- Provide representation to the NASA measurement assurance program for research sensors.
- Provide representation to the NASA metrology technical working group, as mandated by NPD 8730.1

THE NASA DFRC CHIEF OF FLIGHT OPERATIONS (O) OR THEIR DESIGNATED REPRESENTATIVES SHALL:

- Provide contractual oversight of the DFRC calibration contractor.
- Be responsible for establishment and operation of the flight operations research aircraft calibration and repair support laboratory.

THE NASA FLIGHT SAFETY OFFICE (SQ) SHALL:

- Perform periodic surveillance and audits of Center metrology activities per SQ requirements.
- Inform management of discrepancies and areas for improvement.
- Review the monthly calibration delinquency list. Inform users to locate and remove delinquent metrology equipment from service.
- Maintain a file of all metrology extensions granted.
- Implement and monitor a procurement process that ensures all metrology equipment utilized to ensure accuracy of the test equipment, where substantiated data accuracy is required, is routed to the calibration facility for initial calibration and implementation into the recall system.
- Review and concur with DFRC use of metrology equipment labeled and controlled from outside sources.
- Review and concur with waivers for extensions to calibration intervals.
- Review and concur with requests to remove items from the recall list.

THE METROLOGY SUPPORT CONTRACTOR SHALL:

- Develop and implement processes and procedures that assure compliance with the intent of this DCP.
- Manage and operate the calibration support laboratory, assuring all facets are traceable to National Institute of Standards and Technology(nist).
- Perform calibrations/repairs or arrange for calibration/repairs of equipment by outside vendors when requested/required.

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Block 1 continued

- Manage and operate the DFRC metrology recall system.
 - Implement and maintain historical and service records for all metrology items entered into the metrology database and recall system.
 - Ensure all newly acquired metrology equipment entered into the recall system is identified with the DFRC nems bar code labeling system when required, or contractor bar code identification / tracking system.
 - Utilize written calibration and repair instructions. Instructions shall be assembled and maintained by each calibration activity. Instructions shall be numbered or readily identifiable to assure quick reference to a particular procedure, and so the procedure may be noted on tags, historical records, or similar documents, as required.
-

BLOCK 2

All test and critical safety equipment used to perform measurements where substantiated accuracy or safety is required shall be calibrated. Reference NPD 8730.1

BLOCK 3

Aircraft exception instruments are not required to be included in the recall system and are calibrated per applicable aircraft manufacturer pre- and/or post-flight requirements

Aircraft exception instruments include cockpit indicators and gauges which are calibrated per applicable aircraft manufactures pre-/post-flight and/or technical order requirements

Aircraft flight research exception instruments are calibrated per applicable aircraft research engineering instrumentation pre-/post-flight requirements

BLOCK 5

APPLICABLE RI DOP'S.

- DOP-R-403
- DOP-R-404
- DOP-R-405,
- DOP-R-406
- DOP-R-407

APPLICABLE DOCUMENTS:

- DCP-O-002
- DOP-O-403, DOP-O-405
- DOP-R-403, DOP-R-404, DOP-R-405, DOP-R-406, DOP-R-407
- ATTACHMENT 1
- DOP-F-711

All Dryden organizations that utilize and/or have developed in-house metrology operating procedures or instructions to perform calibrations that utilize software to control the calibration process, shall define the method in which the software is controlled within the applicable process and/or procedure used.

Aircraft research instrumentation developmental and system calibration software shall be controlled per applicable research engineering operating procedures.

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BLOCK 9

Exception instruments are defined as instruments and/or components or flight research instrumentation and/or data gathering components and systems installed on, or being processed to be installed on Center aircraft. Exception instruments are calibrated per various flight operations and/or research engineering instrumentation flight research operating procedures including aircraft pre-flight and post-flight inspection requirements.

Exclusions: Certain tools utilized to perform a variety of verification measurements are excluded from the calibration/recall/labeling system. These tools include rulers, measuring tapes, combination squares and various radiuses, screw pitch and thickness measurement/verification gauges. These devices are manufactured and designed to verify design and as built dimensions and do not require calibration. In such cases the user performs a visual inspection of the tool for wear, damage or deformation before use. Worn, damaged, or deformed tools shall not be used and shall be disposed of. Each Directorate Calibration representative shall have a list of tools that fall into this category.

BLOCK 11

APPLICABLE RI DOP'S.

- DOP-R-403
- DOP-R-404
- DOP-R-405
- DOP-R-406
- DOP-R-407

APPLICABLE DOCUMENTS:

- DCP-O-002
- DOP-O-403, DOP-O-405
- DOP-R-403, DOP-R-404, DOP-R-405, DOP-R-406, DOP-R-407
- ATTACHMENT 1
- DOP-F-711

All Dryden organizations that utilize, and/or have developed in-house metrology operating procedures or instructions to perform calibrations that utilize software to control the calibration process, shall define the method in which the software is controlled within the applicable process and/or procedure used.

Aircraft research instrumentation developmental and system calibration software shall be controlled per applicable research engineering operating procedures.

BLOCK 12

Aircraft exception instruments are not required to be included in the recall system and are calibrated per applicable aircraft manufacturer pre- and/or post-flight requirements

Aircraft flight research exception instruments are calibrated per applicable aircraft research engineering instrumentation pre-/post-flight requirements

APPLICABLE RI DOP'S.

- DOP-R-403
- DOP-R-404
- DOP-R-405
- DOP-R-406
- DOP-R-407

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Block 12 continued

APPLICABLE DOCUMENTS:

- DCP-O-002
- DOP-O-403, DOP-O-405
- DOP-R-403, DOP-R-404, DOP-R-405, DOP-R-406, DOP-R-407
- ATTACHMENT 1
- DOP-F-711

All Dryden organizations that utilize, and/or have developed in house metrology operating procedures or instructions to perform calibrations that utilize software to control the calibration process, shall define the method in which the software is controlled within the applicable process and/or procedure used.

Aircraft research instrumentation developmental and system calibration software shall be controlled per applicable research engineering operating procedures.

Exception instruments are defined as instruments and/or components or flight research instrumentation and/or data gathering components and systems installed on, or being processed to be installed on Center aircraft. Exception instruments are calibrated per various flight operations and/or research engineering instrumentation flight research operating procedures including aircraft pre-flight and post-flight inspection requirements.

7.0 METRICS & TREND ANALYSIS

Metrics associated with this activity are documented as part of the metrology support contract performance indicators.

8.0 MANAGEMENT RECORDS & RECORDS RETENTION

DFRC 35, Calibration Status Notice

Retention: 5 years

Archive Location: Bldg 4841

DFRC 704, Parts Control Tag

Retention: 5 years

Archive Location: Bldg. 4841

DFRC 760, Metrology Control Document (MCD)

Retention: Life of equipment +1 year

Archive Location: Bldg. 4841

ATTACHMENT 1

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1.0 PURPOSE

The purpose of ATTACHMENT 1 is to define minimal contractual operational requirements established by Dryden and levied on the Metrology Support Contractor. In addition, it defines the operations and operational interfaces between Dryden's Metrology Support Contractor and the various Dryden organizations that utilize the Contractor's services. The Contractor shall establish internal documents and implement a comprehensive metrology system to support the calibration, recall, perform maintenance, and repair of Dryden's inspection, measuring, and test equipment, assuring accuracy and reliability of affected systems and components as required by NASA Policy Directive 8730.1, Dryden Policy Directive 5339.2 and Dryden Center Procedure DCP-O-007.

2.0 SCOPE

This specification is applicable to metrology equipment used directly or indirectly in all Dryden operations and activities for the testing and acceptance of NASA Dryden products, articles, or systems where substantiated data accuracy or safety is required. (Ref NPD 8730.1)

It is not applicable to those metrology processes or procedural requirements developed to assure calibration of indicating instruments nor research data gathering instrumentation components installed on Dryden aircraft or research aircraft flight test data gathering systems, which are considered exception instruments. (See para.5.2.5) (Ref. DCP-0-007)

3.0 RESPONSIBILITIES

3.1 Calibration Representative

All NASA DFRC Directorate Chiefs and Code X Staff organizations that calibrate or utilize metrology equipment shall designate a Calibration Representative within their Directorate who shall ensure the following within their organizations:

- A. Implementation of this specification.
- B. That all metrology equipment utilized throughout their Directorate where substantiated data accuracy is required is identified and entered into the metrology database, as required.
- C. Review and approval of request for calibration extensions. Follow up on extensions granted to ensure data accuracy was not compromised.
- D. Review and approval of request to remove items from the recall list.

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- E. Review and approval of calibration procedures for specialized test equipment when standard procedures do not exist or are inadequate.
- F. Review of the monthly calibration delinquency list ensuring all metrology equipment within their Directorate is controlled. Initiate immediate action to ensure that delinquent metrology equipment identified is located, placed out of service, and delivered to the calibration contractor. Remove any metrology equipment from the active recall system if it is lost or misplaced for more than 90 days.
- G. Ensure that the quality assurance office is notified when metrology equipment labeled and controlled from an outside source is to be utilized.
- H. Engineering support to the Center's calibration activities as requested/required.

3.2 Chief of Flight Instrumentation (RI)

The NASA DFRC Chief of Flight Instrumentation (RI) or his designated representative shall

- A. Have responsibility for ensuring that Dryden's research data gathering processes assure required data accuracy and reliability.
- B. Provide representation to the NASA Measurement Assurance Program for research sensors.
- C. Provide representation to the NASA Metrology Technical Working Group as mandated by NPD 8730.1.

3.3 Chief of Flight Operations (O)

The NASA DFRC Chief of Flight Operations (O) or his designated representative shall

- A. Provide contractual oversight of the DFRC calibration contractor.
- B. Be responsible for establishment and operation of the Flight Operations Research Aircraft Calibration and Repair Support Laboratory.

3.4 Flight Safety Office (SQ)

The NASA quality assurance office (SQ) shall

- A. Perform periodic surveillance and audits of center metrology activities per SQ requirements. Inform management of discrepancies and areas for improvement.

- B. Review the monthly calibration delinquency list. Inform users or metrology representatives to locate and remove delinquent metrology equipment from service.
- C. Approve and maintain a file of all metrology extensions granted. Perform follow-up to assure that extensions approved did not adversely affect product accuracy/reliability.
- D. Implement and monitor a procurement process that assures all metrology equipment utilized to ensure accuracy of test equipment, where substantiated data accuracy is required, is routed to the calibration facility for initial calibration and implementation into the recall system.
- E. Review and concur with DFRC use of metrology equipment labeled and controlled from outside sources.
- F. Review and concur with waivers for extensions to calibration intervals.
- G. Review and concur with requests to remove items from the recall list.

3.5 The Metrology Support Contractor

- A. Develop and implement processes and procedures that assure compliance with the intent of NPD 8730.1 and DCP-O-007.
- B. Manage and operate the Calibration Support Laboratory, assuring all standards and IM&TE calibrated are traceable to the National Institute of Standards and Technology (NIST).
- C. Assure software utilized to perform calibrations and/or control the calibration process is controlled.
- D. Perform calibrations/repairs or arrange for calibration/repairs of equipment by outside vendors when requested/required.
- E. Manage and operate the DFRC Metrology recall system.
- F. Implement and maintain historical and service records for all metrology items entered into the metrology database and recall system.
- G. Ensure all newly acquired metrology equipment entered into the recall system is identified with the DFRC NEMS bar code labeling system, when required, or Contractor bar code for identification and tracking purposes.
- H. Utilize written calibration and repair instructions. Instructions shall be assembled and maintained by each calibration activity. Instructions shall be numbered or readily identifiable to assure quick reference to a particular procedure and so that the procedure may be noted on tags, historical records, or similar documents, as required.
- I. Provide real-time notification to the user when equipment received for calibration is found to be inoperative or out of tolerance. Route DFRC 35 to the user and a copy to quality assurance office (SQ) documenting the equipment condition ASAP.

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- J. Insure test and calibration equipment, including both hardware and software, is safeguarded from adjustment that would invalidate the test and/or calibration results (tamper/integrity seals).

3.6 Equipment Purchasers

Purchasers of metrology equipment to be utilized where substantiated data accuracy or safety is required are responsible for ensuring that these instruments are identified on the purchase requests and/or credit card orders as requiring calibration, which assures proper acceptance, calibration, and implementation into the recall system.

The procuring organizational group is responsible for ensuring that all newly acquired metrology equipment, used for the testing or acceptance of a product, article, or systems where substantiated data accuracy is required, has been calibrated prior to being placed into service.

3.7 Receiving Inspection

Newly purchased equipment identified as "Calibration Required" by the purchaser and/or Quality Assurance (SQ), upon receipt by receiving inspection, shall be routed to the appropriate calibration activity for entry into the metrology recall database for initial calibration and accuracy verification prior to being placed into service.

3.8 Equipment Users

- A. Ensure that all metrology equipment utilized is properly tagged.
- B. Ensure metrology equipment is properly used and utilized only within its authorized calibration recall cycle.
- C. Ensure metrology equipment past its calibration due date is tagged and placed out of service unless an exemption, by written memorandum and with concurrence of their Calibration Representative and the Quality Assurance Office (SQ), has been granted.
- D. Ensure, upon receipt of the equipment recall MCD, that the equipment is removed from service, tagged with the MCD and placed in branches designated as metrology pick up stations.
- E. Notify their supervisor and quality assurance office (SQ) when informed that calibrated IM&TE is found to be out of tolerance. Upon notification and/or receipt of a DFRC 35 that an item of IM&TE is out of tolerance, the user and their supervisor shall, in turn, notify all recipients of products and services which might have been affected by the "out of tolerance condition". The recipient of the product or service, together with appropriate Engineering authority, shall assess the impact and initiate any corrective action required as a result of the "out of tolerance condition".

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3.9 NASA Dryden Metrology Equipment Utilized by Other Organizations

Whenever NASA Dryden metrology equipment is utilized/loaned to other organizations, it is the responsibility of the equipment custodian to ensure that the equipment loaned is currently calibrated. The borrowing organization must assure the equipment will be returned to NASA Dryden for calibration or repair when required.

3.10 Damaged Metrology Equipment

In the event that an item of metrology equipment has been subjected to excessive heat, mechanical shock, unusual environmental conditions, suspected damage, or if the accuracy is in question, it is the responsibility of the user and/or using organization to immediately process the equipment into the appropriate calibration activity for repair and calibration.

3.11 Uncalibrated Metrology Equipment

All Metrology equipment that lacks a current calibration decal, label, or tag is considered "uncalibrated" and is not to be used or issued for any critical, hazardous, or accuracy sensitive measurements. Such equipment will be clearly marked with an "Indication Only" decal to indicate its "uncalibrated" status.

All custodians and users of metrology equipment, Designated Inspectors, Quality Inspection, and Quality Assurance personnel have the responsibility to vigorously monitor and to take prompt action when required to ensure that only currently calibrated equipment is used for critical, hazardous, or accuracy sensitive measurements.

3.12 Procedures and Controls

The Metrology Contractor shall be responsible for development, coordination, and proper utilization of metrology equipment processes, procedures, and specifications.

The NASA Dryden Quality Assurance office (SQ) is responsible for monitoring calibration activities.

4.0 Definitions and Process Description

4.1 General

The following definitions and process descriptions are established to provide constancy of operation in performing functions pertinent to this Attachment.

4.1.1 Calibration

The set of operations that establishes, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values measured.

The process includes cleaning, lubrication, and other routine minor maintenance or repairs performed to retain the equipment in a serviceable condition or to return the equipment to a serviceable condition.

Calibration is performed at a "Laboratory level" and usually requires removal of the item from service and delivery to the applicable calibration activity. On-site in-place calibration may be performed where it is uneconomic or impractical to perform the calibration in the laboratory.

4.1.1.1 *Calibration Methods*

A. Direct Method

Periodic submission of a standard or item of equipment for direct comparison with a higher-level standard.

B. Transfer Method

An operation wherein certified standards are used at designated and approved locations for the purpose of certifying the accuracy of another lower standard or item equipment and when compared against a "Laboratory Standard " confirms that their validity has not been affected.

4.1.2 Calibration Activity

That organization, unit, or individual officially designated and approved to perform service, repair, and calibration of NASA Dryden metrology equipment.

4.1.3 Calibration Interval

An established period of time between calibrations designed to meet a specified end of period reliability as determined by the equipment

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manufacturer, Air Force Technical Order 33K 100 series, calibration history, or usage.

4.1.4 Certification

The action taken by a responsible calibration facility to attest to the accuracy of a calibrated item.

4.1.5 Comparison Checking

That operation performed using calibrated test and measuring equipment to detect and correct any variation in other test or measuring equipment.

Comparison checks do not replace the normal calibration schedule and do not change the normal calibration recall sequence.

4.1.6 Decal

A small data label affixed to the standards and/or equipment whereby the calibration status can be easily determined.

4.1.7 End of Period Reliability

The probability that an item can perform its intended function within given tolerances throughout a specified interval under stated conditions.

4.1.8 Equipment Record

The card, paper, file, computer program, computer product, or other recording device used by the calibration facility to record all pertinent data on items of metrology equipment under its control.

4.1.9 Instrument

Any device or instrument to measure static or transient phenomena to include all parameters associated with the dimensional, physical, or electrical/electronic characteristics.

4.1.10 Measured

A quantity subjected to measurement. Note: As appropriate, this may be the measured quantity or the quantity to be measured.

4.1.11 Measurement Process

All the information, equipment, and operations relevant to a given measurement.

4.1.12 Metrology

The field of knowledge concerned with measurement.

4.1.13 Metrology Equipment

For the purposes of this attachment, all gauges, measuring devices, instruments, test equipment, and tools used directly or indirectly in all operations and activities for the testing and acceptance of Critical or Safety NASA Dryden products, articles or systems.

4.1.14 Metrology Equipment Custodian

The person whose government property account identifies them as responsible for control and accountability of the equipment. The custodian and user may be the same person.

4.1.15 Metrology Equipment User

The person using the equipment.

4.1.16 Recall System

A systemic operation to ensure that reference, transfer, and working standards and applicable instruments are recalled from the user at prescribed intervals for calibration.

4.1.17 Safety Instruments

Used to monitor or sense potentially hazardous conditions and audibly or visually indicate the occurrence of a hazardous condition.

4.1.18 Standards

An instrument of known accuracy, which is established by authority as a basis for reference measurements.

4.1.19 National Standards

Standards recognized by official national decisions within a country as the basis for fixing the value of all other standards of the quantity concerned.

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In the United States, national standards are established, maintained, and disseminated by the National Institute of Standards and Technology (NIST).

4.1.20 Reference Standards

Standards generally of the highest meteorological quality available at a NASA field installation from which all other measurements are derived. They are typically one echelon below the national standards maintained by NIST.

4.1.21 Transfer Standards

Standards used as an intermediary to compare standards, material measures, or measuring instruments.

4.1.22 Working Standards

Standards which are used routinely to calibrate or check material measures or measuring instruments, usually calibrated against a reference standard.

4.1.23 System Standards

Standards integral to a system that are used to calibrate the system or monitor its uncertainty.

4.1.24 Selection of Required Calibration Standards

The technical requirements of equipment accuracy for each unit will determine the standards required for calibration purposes.

A requirement for a high degree of equipment accuracy will necessarily demand a calibration standard of the finest quality and the utmost in accuracy.

4.1.25 Instrument Measurement and Test Equipment (IM&TE)

All of the measuring instruments, measurement standards, reference materials, and auxiliary apparatus that are necessary to perform a measurement.

4.1.26 Traceability

The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.

4.1.27 Uncertainty

An estimate that characterizes a range of values within which the true value of a measured lies.

4.1.28 Tamper seals/Integrity seals

Used on measuring equipment to prevent tampering with adjustments by unauthorized personnel.

5.0 IDENTIFICATION OF METROLOGY EQUIPMENT

5.1 Calibration Status Label

All gauges, measuring devices, instruments, test equipment, and tools requiring calibration shall be identified with a "calibration status" label or tag that is properly completed and verified.

There are some instruments and devices, such as optical devices, plug gauges, etc., which do not lend themselves to the attachment of labels. In these situations, the label will be attached to the container of the instrument. If there is no container, the custodian shall keep the label on file.

5.2 "Calibration Status" Categories

All gauges, measuring devices, instruments, test equipment, and tools shall be maintained within one of the following categories. Depending on the type and use of the equipment, it will have the correct label attached. Custodians and equipment users are responsible for ensuring that equipment assigned to them is properly labeled.

5.2.1 Calibration Required Decal (Blue Printing on Silver Background)

This category applies to all metrology equipment used to perform measurements where substantiated data accuracy or safety is required and must be included in the recall/calibration system. As a minimum, all metrology equipment used to perform measurements associated with the following functions will be calibrated.

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- A. Acceptance testing.
- B. Inspection, maintenance, calibration, and /or qualification of flight hardware.
- C. Measurements of processes where instrument accuracy is essential to ensure safety of personnel.
- D. Telecommunications, transmission, and test equipment where exact signal interfaces and circuit confirmation is essential.
- E. Development, testing, and special applications where the specifications, end products, or data accuracy are sensitive.

All Instruments used to perform measurements where substantiated data accuracy is required shall be included in the Calibration Recall system, periodically calibrated, and clearly labeled to indicate the calibration status and the due date of the next calibration.

It is the responsibility of the property custodian to identify all instruments in their organization that meet the listed criteria and coordinate with the calibration laboratory to ensure that they are entered into the master file, labeled, and made available for pick-up at the designated time and place.

Metrology equipment not used in the functions listed above may be included in the Calibration Recall System at the request of the property custodian.

5.2.2 Indication Only Decal (Red printing on a white background)

Applicable to all metrology equipment used to perform measurements where substantiated data accuracy is not required. Any instrument that is excluded from the Calibration Recall System will be labeled with an "Indication Only" decal and will be considered to be uncalibrated and used only:

- A. To perform measurements associated with research and development, test, etc., where substantiated data accuracy is not required.
- B. For process monitoring or indication purposes in a non-hazardous environments where accuracy is not required.

The calibration laboratory will distribute "Indication only" decals to Directorate calibration representatives who will be responsible for distribution and installation on the appropriate Directorate instruments.

Instruments bearing the "Indication Only" decal will not be included in the Calibration Recall system unless previously identified as a calibrated item. Whenever instruments in this category are to be upgraded from "Indication Only" to "Calibration Required", the "Indication Only" decal shall be immediately removed, voided, or destroyed and the instrument processed through the calibration laboratory and added to the calibration recall system. A "Calibration" decal will be properly completed and affixed to the unit before use.

In those instances where an instrument is changed to "Indication Only" from calibrated status, the user will remove the calibration decal and affix an "Indication Only" decal. The Calibration/Recall database will reflect a calibration interval of zero months in these cases.

5.2.3 Limited Use Calibration Decal (Green printing on a silver background)

The limited use calibration decal indicates that the instrument has not been calibrated for every function over its full range or to procedure specifications for various customer or contractor reasons. The property custodian and calibration contractor will mutually agree that it is appropriate to calibrate and designate the equipment as "limited use". As such, the equipment shall not be used for those functions not calibrated. A description of limitations will be entered on the Metrology Control Document (MCD) and the limited use calibration decal, which is returned to the user with the calibrated instrument.

5.2.4 Equipment Warranty Decal (Orange writing on white background)

The Warranty decal is used in conjunction with other decals to track warranty status of the equipment.

5.2.5 Exception Instrument (Label not required)

Exception instruments are processed through work order processes, controlled with parts control or serviceable tags, and are not required to be included in the Contractors calibration/recall system.

There are research situations and operational practices in which calibration is required and where alternative methods to the recall/calibration system have been implemented to ensure adequate levels of instrument accuracy.

Cockpit instruments and flight research instrumentation components and system that are installed in flight-test vehicles and facilities and calibrated in-place during pre-flight and post-flight operations are examples of exception instruments.

Instrument accuracy is ensured by the use of transfer and working standards that are included in the recall/calibration system.

Evidence of compliance with the provisions of NPD 8730.1 is generally included in written calibration procedures that are utilized during the flight research vehicles preflight and post flight inspections, which are auditable by third party inspection.

In those cases where written procedures do not exist for a specific item installed in a data gathering system, NASA Engineering is responsible for developing the process (normally a pre/post flight calibration) that assures calibration of the system is performed and documented.

Authority for granting exceptions is delegated to the organization directors, and they are responsible for compliance with the provisions of NPD 8730.1 with respect to such exceptions.

An interoffice memorandum designating those instruments considered to be in the exception category, with the Organizational Directors Calibration Representative and Dryden Quality Assurance office (SQ) approval, will be on file and available for any third party inspection.

5.2.6 Standards Labels

All instruments used as standards as defined in paragraph 4.1.16 shall be labeled with the appropriate NASA standards labels. All reference, transfer, and working standards used in the calibration process shall be recalled and recalibrated at established calibration intervals, and it is mandatory that they be included in the recall/calibration system.

5.2.7 Working Standard (Yellow Label with Black Printing)

Standards which, usually calibrated against a reference standard, are used routinely to calibrate or check material measures or measuring instruments.

5.3 **Non-Dryden Labels and Tags**

In certain cases, metrology equipment used by Dryden personnel is owned and controlled by other agency's metrology control system. Utilization of equipment

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with calibration status labels and tags other than those controlled and used by the Dryden Flight Research Center may be used.

In such cases, the use of equipment with non-Dryden metrology labels and tags shall be approved by the Dryden Quality Assurance Office (i.e. USAF, Navy, Army, Contractor.).

6.0 RECORDS REQUIREMENTS

6.1 Equipment Records

The Calibration Laboratory shall maintain an "Equipment Record" file, which will contain all pertinent data on the items of metrology equipment under its control, as well as calibration intervals and the date on which each instrument comes due for calibration.

A record shall be maintained for each instrument and should include the following information when applicable:

- A. Instrument Description
- B. Serial Number
- C. Model Number
- D. Equipment Control Number (ECN)
- E. Manufacturer's Name
- F. Custodian, User (unit and individual)
- G. Calibration Activity
- H. Reason for Submission, verification, new instrument (initial acceptance), recall, calibration or repair
- I. Tolerances and Characteristics to be checked
- J. Calibration Date
- K. Previous Service Date
- L. Next Calibration Due Date
- M. Calibration Interval
- N. Calibration Data, Remarks, Limitations, Repairs or Servicing Performed
- O. Standards Used
- P. Calibration Interval Adjusted
- Q. Verification
- R. Calibration Status Category (type of label affixed to instruments)

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The Equipment Record, in addition to providing an inventory and historical record of all metrology equipment under jurisdiction of the Contractors Calibration Laboratory, shall be so arranged that it will constitute a "Recall" file with positive indication of the calibration due date for each instrument in the Recall/Calibration System.

6.2 Master File (Recall/Calibration System)

The Calibration Laboratory shall maintain a " Master File" that lists all instruments included in the Instrument Recall/Calibration System. These files shall be so arranged that each instrument comes up for Recall automatically according to scheduled calibration due dates. Scheduling and record controls shall be maintained in such a manner that a continuous record of maintenance and calibration exists for each instrument. Hard copy files, computer generated data, or a combination may constitute this file.

6.3 Metrology Control Document (MCD) (DFRC 760)

The NASA Metrology Control Document (MCD) shall be used to document all maintenance activity on instruments included in the recall/calibration system. The Metrology Control Document shall be the central document in the equipment historical record file and shall provide the required historical and service information for each item of metrology equipment.

6.4 Parts Control Tag (DFRC 704)

The NASA Dryden Parts Control Tag form DFRC 704 may be used to request initial calibration and/or repair services from the Calibration laboratory. The parts control tag may be used as a processing document to describe instrument condition and to identify work requested.

Upon completion of the instrument calibration/repair, the parts control tag will be completed documenting services performed and condition of the instrument with a copy retained in the instrument's equipment record file. The completed tag will be attached to the item upon return to the user. For instruments that require entry into the recall system, a metrology control document will also be attached to the instrument and delivered to the user.

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6.5 Calibration Status Notice (DFRC 35)

The NASA Dryden Calibration Status Notice shall be used to notify the user if the equipment is found to be significantly out of tolerance and /or of any deviation from the normal calibration routine. If an item of metrology requires parts, is sent to an off site calibration facility, or returned to the manufacturer for warranty or other repair, this document will be filled out and forwarded to the user.

Upon notification and/or receipt of a DFRC 35 that an item of IM&TE is out of tolerance, the user and their supervisor shall, in turn, notify SQ and all recipients of products and services which might have been affected by the "out of tolerance condition". The recipient of the product or service, together with appropriate Engineering authority, shall assess the impact of and initiate any corrective action required as a result of the "out of tolerance condition."

6.6 Calibration Standards Certification Records

All standards used in calibration of metrology equipment shall have certification records traceable to the National Institute of Standards and Technology. Evidence of certification shall be on file at the calibration activity.

7.0 RECEIVING ACCEPTANCE CALIBRATION PROCEDURE

All newly purchased metrology instruments to be utilized to perform measurements where substantiated data accuracy or safety is required must receive initial acceptance, calibration, and entry into the recall system prior to delivery to the user and incorporation into service. The procurement/receiving document shall identify "measuring and test instruments" requiring acceptance and initial calibration. Initiators of the Purchase Request/Purchase Order/Credit Card purchases and the Quality Assurance office are responsible for ensuring "Calibration Required" instruments are properly identified, received, and processed.

7.1 Recall Cycle

All new instruments are automatically put on a recall cycle of twelve (12) calendar months unless the Calibration Contractor, manufacturer's, Technical Order recommendation, or user request is more stringent. All instruments will be recalled thirty (30) days prior to the expiration of the warranty period.

Property custodians/users may request deviations to established calibration intervals or exemption of the instrument from the Recall System. The user shall draft a written memorandum to the Calibration Laboratory requesting the action/deviation that shall have the documented concurrence of their Directorate Calibration Representative and the Quality Assurance office.

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Attachment A has been prepared to assist in identifying instruments and other equipment which may be routed to the calibration laboratory for acceptance testing, calibration, and addition to the recall system.

8.0 METHODS OF OPERATION

8.1 General

Initial acceptance calibration, periodic calibration, and non-scheduled calibration as required, and are the responsibility of all personnel concerned with the procurement, custody, use, and servicing of any item of metrology equipment.

Monitoring of calibration due dates, proper scheduling of equipment, rapid turn around of calibrations, and prompt pick-up and return of equipment to the equipment user are key requirements for successful operation of the metrology system.

8.2 Instrument Recall/Calibration System

The Calibration Laboratory shall maintain a "Master File" that lists all instruments included in the Instrument Recall/Calibration System. These files will be arranged so that each calibrated instrument comes up for recall automatically on the calibration due dates.

8.2.1 Calibration Intervals

Calibration intervals shall be established for each instrument taking into consideration the following:

- A. Type of equipment
- B. Facts relative to the equipment as per manuals, bulletins, specifications, and instructions.
- C. Type of handling required (fixed, portable, mobile).
- D. Built in standards or self-check capability.
- E. Accuracy of the equipment.
- F. Extent and frequency of use.
- G. Environmental conditions in the area of use.
- H. Manufacturers recommended calibration interval.
- I. Historical data on the unit and similar units.

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Units under warranty will be assigned a shortened calibration interval to ensure that the unit is totally serviceable prior to warranty period expiration.

Directorate Chiefs or their designated representative are encouraged to review the records for the purpose of adjusting the calibration intervals. All of the factors mentioned in this paragraph shall be taken into consideration before adjustments to increase or decrease the calibration interval.

8.3 Instrument Calibration Recall, MCD Responsibility, Custodian

The user is required to withdraw the recalled instruments from service and submit them for calibration prior to the calibration due date. The user will complete blocks 32, 36 (optional), 37, 38, and 39 on the MCD. The Metrology Control Document shall be attached to the instrument and the instrument placed in the Branches designated metrology recall station. The Calibration lab will be responsible for pick up and safe transportation of the equipment to the Calibration facility.

8.4 Instrument Calibration Recall, MCD responsibility, Calibration Technician

After completion of the calibration/repair, the calibration technician will be responsible for the completion of blocks 40 through 55 on the MCD. A copy of the completed MCD shall be attached to the equipment, and the calibration lab will be responsible for safe return of the equipment to the recall station after calibration.

8.5 Historical File

The historical file will consist of the metrology control document copy (four (4) completed), for each calibration or repair, along with any certifications hard copy data or any communications, which deal with the calibration cycle or the removal from the recall system.

8.6 Master File

The working file will be a computerized data base information system which will form the basis for recall system, printing of the MCDs, initiation of the overdue listings, and provide data for the weekly and monthly reports.

8.7 Calibration Procedures

Calibration of the instruments will be in accordance with the manufacturer's manual or specifications, the Air Force 33K series Technical Orders, or the appropriate NAVAIR Technical Publications. A standard accuracy ratio of at

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least four to one (4:1) shall be applied except where the state-of-the-art will not allow this level of accuracy. Whenever standards with a ratio of less than 4:1 are used, the accuracy ratio used will be documented on the Calibration report or the Metrology Control Document (MCD). A copy of these documents will be returned to the user with the calibrated instrument.

In the event that there are no calibration procedures available, the calibration laboratory, in agreement with the Chief of Flight Instrumentation or his designee and the Dryden Quality Assurance Office, will develop the process/specification to which the unit will be calibrated.

8.8 NASA-Originated Metrology Equipment

Components/items of equipment designed/fabricated by NASA Dryden shall be calibrated and maintained in accordance with the procedures established by the Chief of Flight Instrumentation (MI) or his designated representatives.

8.9 Overdue Instruments Notification/Delinquent List

At the end of each month, the Metrology Support Contractor shall develop a delinquent list of those instruments overdue for calibration. A copy of the monthly overdue list will be sent to affected Directorate Chiefs, Calibration Representatives, the Dryden Quality Assurance Office, and the Calibration Contractors COTR before the tenth (10th) of each month for appropriate action.

Directorate Chiefs and Calibration Representatives will be notified by memo when no IM&TE is delinquent for any given month.

8.10 Overdue Calibration/Interim Extension

In the event that the calibration due date for an item of metrology equipment occurs at a time when the equipment is in use, and replacement or substitute equipment is not available or it would be unwise to replace the unit due to the complexity of the calibration being performed, an "interim extension" of the calibration due date may be granted.

It shall be the responsibility of the Directorates Calibration Representative, a representative of the Quality Assurance Office, and other personnel directly concerned to review the operation of the equipment and determine if the condition and accuracy of the equipment is such that the calibration due date can be extended until completion of the operation.

The user shall draft a written memorandum to the Quality Assurance requesting an extension, which shall have documented concurrence of their Directorate Calibration Representative and the Quality Assurance office. The Directorates Calibration Representative and the user, in conjunction with the Quality

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Assurance Office, shall follow up and assure the extension did not affect product reliability.

Interim extensions are not to be considered "normal operation" and should not exceed ten (10) days. All questions regarding "interim extensions" shall be referred to the Metrology Support Contractors Calibration Manager and the Dryden Quality Assurance Office.

9.0 CALIBRATION INTERVALS

9.1 General

All instruments used to perform measurements where substantiated data accuracy is required shall be included in the instrument recall/calibration system and periodically calibrated at established calibration intervals. Each calibrated instrument shall be assigned a calibration interval based upon careful analysis of the requirements and other influencing factors as specified in paragraphs 7.0 & 8.0.

9.2 Initial Calibration Interval (New Instruments)

At initial addition to the Calibration/Recall system, instruments are assigned a recall cycle of (12) twelve calendar months unless the Calibration Contractor, Manufacturers, or Technical Order recommendations are more stringent. All instruments will be recalled thirty (30) days prior to the expiration of the warranty period.

9.3 Calibration Interval Extensions

In unique instances, metrology equipment is required to be made available and calibrated, but may not be utilized during its Calibration cycle. The most common source of this type of equipment is the Test Equipment Loan Pool and various Shuttle support IM&TE, all of which are stored in a controlled area until used. In these instances, calibration extensions may be granted.

In these instances, when the IM&TE is stored and not expected to be utilized, the Calibration Technician will affix the appropriate calibration label with expiration date, then seal the equipment with a tamper-resistant seal and/or sealing wrap upon completion of calibration.

Metrology equipment on a 12-month recall cycle, controlled and identified in this manner, may have its calibration cycle extended one calibration period, not to exceed an additional 12 months.

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Metrology equipment on a 6-month recall cycle, controlled and identified in this manner, may have its calibration cycle extended three calibration periods, not to exceed 24 months between calibrations.

Prior to extending the calibration, the equipment will be visually inspected by the Calibration Technician and the calibration due label replaced reflecting the new "due date".

9.4 Test Equipment Loan Pool (TELP) Normal Calibration Cycling

In order to ensure serviceability of IT&ME loaned from the TELP, all IM&TE will be calibrated upon return from the user, and the 12-month calibration cycled re-initiated.

All TELP IM&TE will be placed on a twelve (12) month calibration cycle with the option to extend it 12 months per Paragraph 9.3.

9.5 Removal of lost or missing equipment from the recall system

Lost or missing capital equipment that is being tracked by the recall system shall be reported as missing to NASA/DFRC Security by the custodian/user. The custodian/user shall also notify the Metrology Contractor and request the metrology delinquency list reflect that the item is missing.

NASA/DFRC Security will complete the DFRC 123 form and the equipment user/custodian will request a copy be forwarded to the Metrology Support Contractor with copies forwarded to the Chief, Supply, and Equipment Management Office.

If the results of a search for the lost or missing equipment fail to locate the item, the user/custodian will be notified by the Equipment Management Office and be required to submit a lost/survey form. The user/custodian should deliver completed copies of the survey form to the Metrology Support Contractor requesting removal of the item from the recall system. Upon receipt of the survey form, the missing equipment will be removed from the NASA DFRC calibration recall system.

10.0 TYPICAL INSTRUMENTS ELIGIBLE FOR CALIBRATION LABORATORY SUPPORT

Amplifiers	Gages	Scale with Weights
Analyzers	Generators	Scalers
Attenuators	Hygrometers	Scanners
Barometers	Indicators	Sine Bars
Blocks	Levels	Sine Plates
Bridges	Load Cell	Squares
Calibrators	Manometers	Standard Cells
Calipers	Meters	Straight Edges (Precision)
Capacitance meters	Micrometers (all types)	Strobe Scopes
Clinometers	Modulation Oscillators	Synchronizers
Clocks	Monitors	Tachometers
Controllers (Temperature)	Oscilloscopes	Tensiometers
Converters (Frequency)	Potentiometers	Thermocouples
Counters (Electronic)	Power Supplies	Thermometers
Couplers (Directional)	Pressure Test Sets	Timers
Crimp Tools	Probes	Torque Wrenches
Decade Resistors	Protractors	Transducers
Detectors	Pyrometers	Units (Time Interval)
Digital Comparators	Ratio Set	Voltage Standards
Dividers (Sweep)	Receivers	Watches (Stop)
Filters	Recorders	Weight Sets
Frequency Standards	Regulators (voltage)	(Microvolt/Gageblocks)

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Document History Log

Status Change	Document Revision	Effective Date	Page	Description of Change
Baseline		02/09/99		
Revision	A	03/19/99	1	Modified functions of the Inspection, Measuring, and Test Equipment (IM&TE) Purchaser/User to read as: "Assure Quality Assurance procurement review of metrology equipment per DCP-S-003, DCP-A-007" in Column 1, Block 1. Move out arrow of Column 3 Block 2 from Column 3, Block 1 to Column 3, Block 2. Add 6, 7 in Column 2, Block 2 Add 7 in Column 5, Block 1
			2	Corrected formatting and spelling
			3	Deleted 4018.402 from Notes 6 and 7. Add DOP-O-405 to Note 7 Change DCP-O-003 to DCP-O-002
Revision	B	03/24/99	1	Deleted reference to Note 9 from 4 th block of IM&ST Purchaser/User.
Revision	C	04/08/99	All	Speck checked entire document and made correction as necessary.
Revision	D	02/25/03	All	Add cover page, Purpose, and Scope & Applicability sections, redraw flowchart, reformat Notes, add Attachment 1: Process Specification # 02-2.
Admin. Change		10-02-03	All	Changed inaccurate reference from Code SF to Code SQ on page 17. Correct formatting errors. Move Document History Log to end of document.
Revision	E	2-6-04	All	Section 6.0, Block 9: Added second paragraph "Exclusions". Removed references to DPD-5339.2.

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